

Space Weather Technical Forecast

Issued on Thursday, 10 February 2022 at 01:54 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Slight chance of G1/Minor Storm activity on day 1 (10 February), associated with CME arrival. Chance of a G1 later on day 3 (12 February) or on day 4 (13 February) due to Coronal Hole influences. Active electron fluence expected days 1 and 2 (10 and 11 February). Chance of an M-class flare.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been low over the last 24 hours, with occasional C-class flares. The most energetic of these was a C5.7 at 09/1736 UTC from 2939 (Cho/Beta), a large mature region in the southwest quadrant. Two regions in the northern hemisphere, 2941 (Fai/Beta) and 2940 (Dai/Beta) are both large, carry a flare risk. 2943 in the southeast, is small and benign and uni-polar (Axx/Alpha). A NEW region has developed south of 2939, this too is unipolar and weak. No further Earth directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind at L1 has fluctuated but the overall trend was easing back from slightly elevated levels around 470 km/s to background levels around 380km/s. However, at 09/2010 UTC the speed suddenly increased to around 420km/s, the density increased from 2 ppcc to 9 ppcc and the IMF from 4 to 8nT, while these numbers are unremarkable this may indicate the arrival of a weak CME which left the Sun on the 6th February. The north-south component, Bz, remained weak varying between +3nT and -4nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV) has been above the high threshold throughout, peaking at 1.02e4 pfu at 09/1550 UTC. Electron fluence values are above the Active (1e8 integrated pfu) threshold on a steady trend, reaching 4.95e8 integrated pfu at 09/2359 UTC.

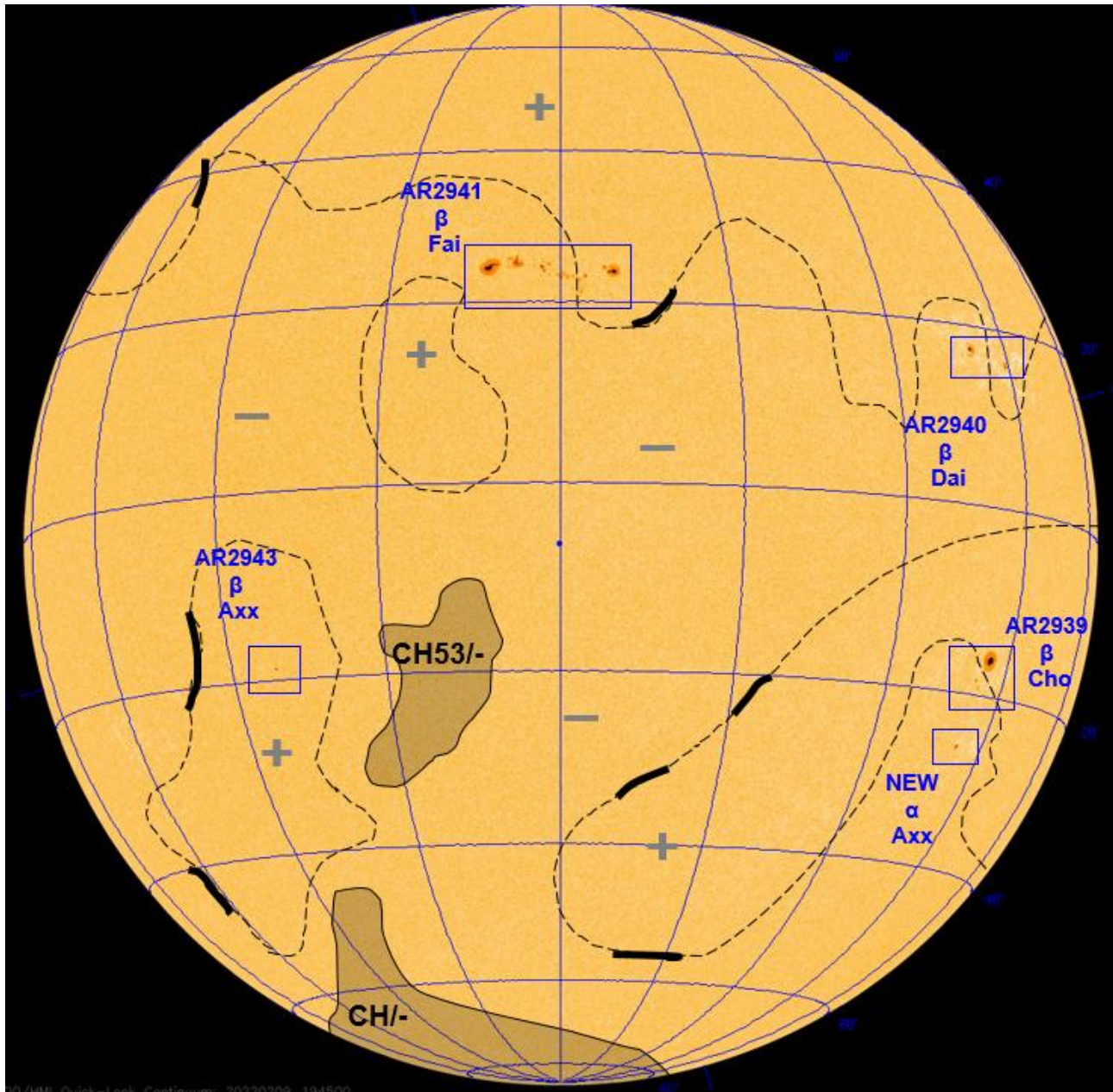
Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to remain low through the next four days, with a chance of an isolated M-class flare due to the three large active regions currently observed on the visible side of the solar disc.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 06 February may have arrived just after 09/2000UTC, though it was much weaker than earlier predicted, there remains a chance that this event was not, in fact, the main CME and there is a chance CME activity may be observed early on day 1 (10th February). If this occurs the CME may then perturb the geomagnetic environment around the Earth over the following 24 hours or so. The high speed stream from coronal hole 53 is expected to connect with the Earth late on day 3 (12 February) or on day 4 (13 February). Geomagnetic activity mainly Unsettled with Active intervals at first and a slight chance of G1/Minor Storms. Residual and decreasing effects of the CME through day 2 (11th February) will see geomagnetic activity mainly at Quiet levels. The onset of the high speed stream from coronal hole 53 on day 3 or 4 will see an increase in geomagnetic activity to Unsettled to Active and a chance of G1/Minor Storms.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is forecast to be at background levels, but with a slight chance of rising close to, or just above, the S1 level given any significant flares. High energy electron flux is likely to fall below the high (1e3pfu) level by day 2 (11 February) post arrival of the CME, recovery is then uncertain. Active (1e8 integrated pfu) electron fluence levels on day 1 (10 February) with a decline during day 2 (11th February). Any recovery is subject to the behaviour of the electron flux following the CME.

Figure 1. Solar Analysis Valid *.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A CME which left the Sun on the 6th February may have arrived as a very weak feature late on the 9th. There remains a chance the event in question may not have been the main CME and operators will need to remain vigilant at first on day 1 (10th Feb) in case of more significant activity.

Enlil suggested that the main portion of this feature may have passed to the east of the Earth, and this may well be what has occurred. The MOSWOC Enlil ensemble gave a fairly wide spread for arrival times, hence the caution during day 1 (10th Feb). The next coronal hole high speed stream, from coronal hole 53, looks set to arrive either late on day 3 (12 February) or on day 4 (13 Feb), with peak of 600-700km/s, based on persistence from this recurrent feature.

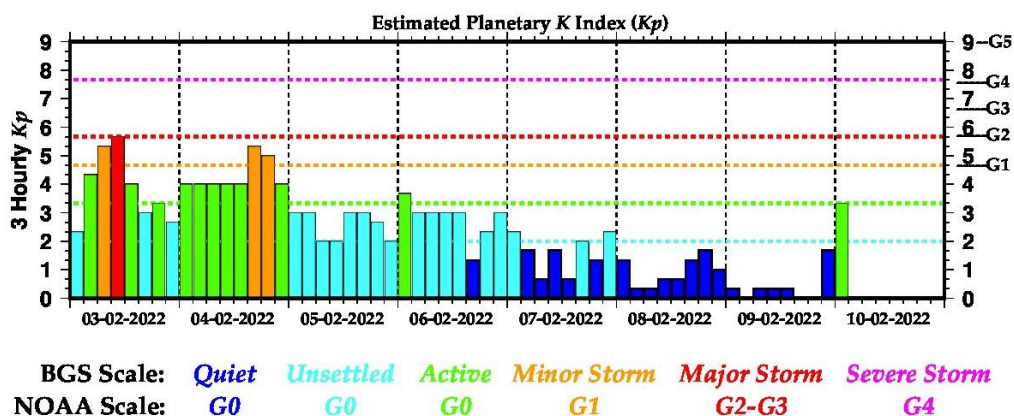
Geomagnetic activity is expected to start Unsettled with Active intervals and a Slight Chance (20%) of G1/Minor Storms should the main part of the CME arrive early on day 1 (10th).

Residual effects of this CME are then possible through to day 2 (11th Feb), this is dependent on the post-shock magnetic sheath. The onset of the equivalent high speed stream from coronal hole 53 generated G1/Minor Storms on the last rotation, with the chance of a similar effect this time late on day 3 or on day 4 (12th or 13th).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	10	40	40
Strong	G3	No	1	1	5	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections- Nil

Figure 2: BGS Kp index

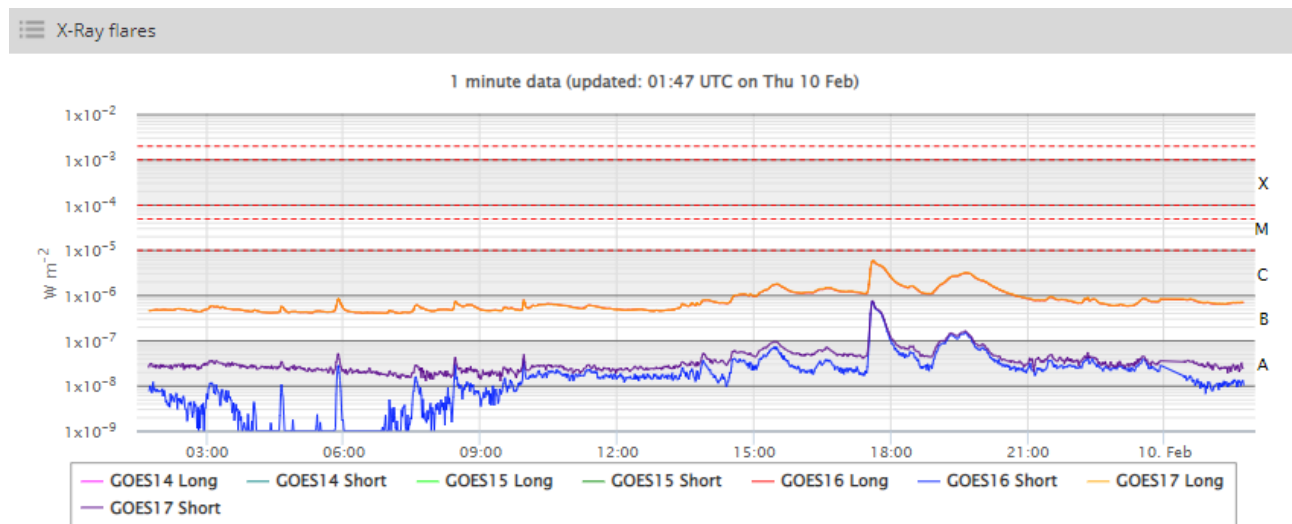


Radio Blackouts - X-Ray Flares:

There are four sunspot regions on the visible disc, with three of the larger regions, 2939, 2940 and 2941 all passing through periods of development, with subsequent subdued periods. 2941 is the largest region and classified as Fai/Beta, with several intermediate spots in evidence. 2940 (Dai/Beta) seems to be relatively stable with the looping appearing uniform. 2939 (Cho/Beta), from where the 06 February CME emanated, produced a C5.7 flare on the 9th Feb. 2943 is currently benign with a uni-polar structure (Axx/Alpha) and is a NEW region in the southwest. Solar activity is expected to be mainly low, with further, mostly low level, C-class flaring continuing. Based on the position and history of the three largest regions, there is a chance of an M-class flare through the next 4 days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: GOES16 X ray flares



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are not expected in the period. However, there is a very slight chance for proton fluxes to rise given any significant flaring from AR2939 and AR2940, as they continue to transit across the western hemisphere.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. ($\text{pfu} = \text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) starting at high ($>1\text{e}3\text{pfu}$) levels is likely to fall sharply should any enhanced geomagnetic activity from the CME occur. Any CME could also distort the radiation belts away from GEO. Following the CME arrival confidence in the behaviour of the electron flux decreases, as this depends on the extent of the post CME shock and how quickly the radiation belts may return to an unperturbed state.

24-hour fluence values are expected to remain above the Active ($1\text{e}8$ integrated pfu) threshold through day 1 and 2 (10th and 11th), but then decline as the electron flux decreases from day 2 (11th February). The probabilities represent the uncertainty in the level of decline and then the speed of any recovery.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	Yes	100	90	60	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	5	5	1	1

Figure 4:GOES16 ElectronFlux (top) remains above 1000pfu . REFM (below) shows a declining trend.

